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Chromium Oxide Coatings Improve Thermal Emissivity of Alumina

The problem:

To improve the thermal radiation characteristics of alumina-coated surfaces of heater-cathode systems used in vacuum tubes. Carbon impregnation of the radiating surfaces is presently used to provide improved thermal radiation, but at operating temperatures of 1100° to 1400° C, the carbon migrates into adjacent tungsten parts (particularly where a tungsten heater is located inside a tungsten sleeve) and causes warping.

The solution:

Apply chromium oxide either as a surface layer or as a doping material to the sintered alumina heater coating. The new coatings provide better thermal radiation than the alumina alone and eliminate the high-temperature migration problems of carbon surface treatments.

How it's done:

The coating mixture is prepared by blending 50 grams of chromium sesquioxide (Cr_2O_3), 5 grams of aluminum nitrate ($\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$), and 2 grams of magnesium nitrate ($\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$) into 200 ml of a commercial coating solution, which is then diluted to a total volume of 400 ml with equal parts of ethyl alcohol and deionized water. This preparation is then used for coating the sintered alumina heater

surfaces by cataphoresis at 45 volts dc for 5 to 6 seconds (to obtain a coating of approximately 0.003 inch thick). The resultant coating is set by heating at 1600° to 1700° C in moist hydrogen.

Notes:

1. A satisfactory coating can be obtained by painting a water solution of chromic anhydride (CrO_3) on the sintered alumina heater surfaces, followed by heating in moist hydrogen.
2. Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Western Operations Office
150 Pico Boulevard
Santa Monica, California, 90406
Reference: B66-10227

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C., 20546.

Source: Vert Upshaw
of Hughes Aircraft Company
under contract to
Western Operations Office
(WOO-263)

Category 03